

AD 718591

Materiel Test Procedure 6-3-085
U. S. Army Artillery Board

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3446
U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY SERVICE TEST PROCEDURE

FIRE DIRECTION EQUIPMENT, MANUAL

1. OBJECTIVE

The purpose of this MTP is to outline service testing techniques and methodology necessary to determine, under field operating conditions, the degree to which the test item and its associated tools and test equipment perform the mission as described in the QMR, and the suitability of the item and its maintenance package for use by the Army.

2. BACKGROUND

A requirement exists for a manual fire direction system for all field artillery cannon weapons to determine firing data faster, more accurately, and with greater flexibility than the present manual system. The battlefield today is characterized by widely dispersed small actions of high shock intensity requiring the command and control element of field artillery units to displace frequently and quickly in order to survive, while still providing uninterrupted support. Manual equipment provides a separate operation fire direction center for "jump" displacement without the great expense of duplicating the primary (automated) equipment.

The relatively light weight, ruggedness, and simplicity of manual fire direction equipment makes it especially adaptable to airborne operations where the weight, bulk and sensitivity of computers and associated equipment are delimiting factors in employment of automated systems.

A manual system is particularly appropriate for infantry mortar fire direction elements operating near the forward maneuver elements.

3. REQUIRED EQUIPMENT

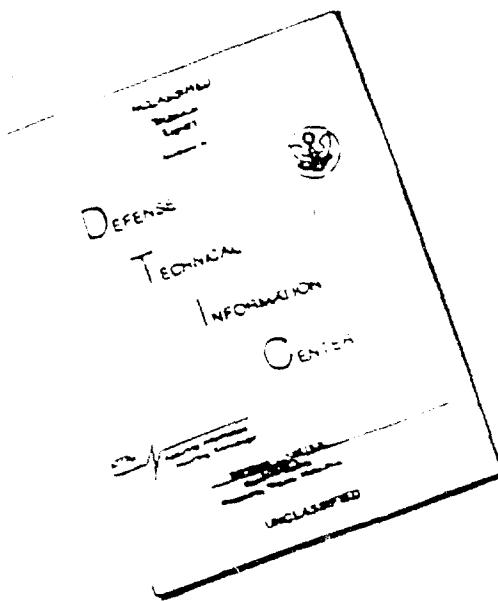
- a. Suitable indoor space to install and operate the test item.
- b. Transportation, as required.
- c. Current Standard A Manual FDC Equipment, if required.
- d. Current Standard A Computerized FDC Equipment.
- e. Communications, as required.
- f. Field service test area, as required.
- g. Appropriate weapons and projectiles, as required.
- h. Calipers, scales, or other appropriate measuring equipment for determining accuracy of test item component.
- i. Tentage, as required.
- j. Camera and film.

4. REFERENCES

- A. USATECOM Regulation 385-6, Verification of Safety of Materiel During Testing.

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QUALITY AVAILABLE. THE COPY
FURNISHED TO DTIC CONTAINED
A SIGNIFICANT NUMBER OF
PAGES WHICH DO NOT
REPRODUCE LEGIBLY.

- B. USATECOM Regulation 750-15, Maintenance Portion of the Service Test.
- C. FM 6-40, Field Artillery Cannon Gunnery.
- D. Tabular Firing Tables, as required.
- E. MTP 6-3-500, Physical Characteristics.
- F. MTP 6-3-501, Technical Inspection.
- G. MTP 6-3-502, Personnel Training Requirements.
- H. MTP 6-3-505, Emplacement, Action, and March Order.
- I. MTP 6-3-506, Durability.
- J. MTP 6-3-509, Effect of Weather.
- K. MTP 6-3-510, Transportability of Communication, Surveillance, and Electrical Equipment.
- L. MTP 6-3-517, Electrical Power Requirements.
- M. MTP 6-3-523, Safety.
- N. MTP 6-3-524, Maintenance Evaluation.
- O. MTP 6-3-525, Human Factors.
- P. MTP 7-3-512, Air Drop Capability (Suitability of Equipment for).
- Q. MTP 7-3-515, Air Transport, Internal (Suitability of Equipment for).
- R. MTP 7-3-516, Air Transport, External (Suitability of Equipment for).
- S. MTP 10-3-503, Surface Transportability (General Supplies and Equipment).

5. SCOPE

5.1 SUMMARY

This MTP describes the methodology, techniques and the subtests required for the determination of the man-equipment compatibility and the capability and suitability of the test item for use by the Army. The major areas and their included subtests are:

a. Pre-Test Operations consisting of:

- 1) Technical Inspection - A check to verify that the test item is complete and in satisfactory condition prior to the start of testing.
- 2) Physical Characteristics - A verification of the physical characteristics of the test item.
- 3) Electrical Characteristics - A verification of the test item's electrical characteristics and a determination of its power requirements, when applicable.

b. Operational Characteristics consisting of:

- 1) Emplacement, Preparation for Action and March Order - An evaluation of problems or equipment deficiencies in emplacing, preparing for action and march ordering the test item.
- 2) Operability - A determination of the speed and relative complexity of exercising technical fire control using the test item.
- 3) Accuracy - An evaluation of the accuracy of the test item components and system.

c. Transportability Tests consisting of:

- 1) Surface Transportability - A determination of the suitability of the test item for surface transport.
- 2) Air Transportability - A determination of the suitability of the test item for external and internal transport by aircraft and air drop.
- 3) Man Transportability - A determination of the suitability of the test item for transport by an individual soldier(s).

d. Full-Test Evaluations consisting of:

- 1) Durability - An evaluation of the capability of the test item to withstand being transported over various types of terrain for a specified number of miles.
- 2) Maintainability and Reliability - An evaluation to determine the maintainability of the test item, the adequacy of its maintenance package, and its overall ability to operate over long periods of time without adjustment or replacement of components.
- 3) Effects of Weather - An evaluation of the effects of various weather conditions on the operability of the test item.
- 4) Human Factors - An evaluation of the suitability of the test item for operation, maintenance, transport and storage by service personnel without causing undue fatigue and mental errors.
- 5) Safety - An evaluation of the safeness of the test item in its various configurations, under a variety of conditions, and resultant safety hazards to service personnel.
- 6) Value Analysis - Observations of the test item during the period of testing to determine possible ways to eliminate unnecessary costs at various stages of the design development and testing program.

e. Post-Test Inspection - A repetition of the technical inspection to determine any adverse effects of testing on the test item.

5.2 LIMITATIONS

None

6. PROCEDURES

6.1 PREPARATION FOR TEST

6.1.1 Scheduling

6.1.1.1 Personnel Training

a. Ensure the availability of service personnel who have been, or are being, trained using the criteria of MTP 6-3-502 and are knowledgeable of the operation and maintenance of the test item.

b. Record the following for all service personnel:

- 1) Rank
- 2) MOS
- 3) Training time in MOS
- 4) Experience in MOS

c. Ensure that experienced personnel are available for the duration of testing.

d. Determine and record the adequacy of the training literature furnished with the test item.

6.1.1.2 Facilities and Equipment

a. Select and schedule the use of adequate fixed installation fire direction center (FDC) space and field test sites.

b. Arrange for or secure the following:

- 1) Vehicles for transporting the test item
- 2) Maintenance support facilities and personnel, as required
- 3) Computerized FDC equipment and trained crew

6.1.2 Pre-Test Operations

6.1.2.1 Physical Characteristics

Verify that the physical characteristics of the test item conform to military specifications by performing the procedures described in the applicable sections of MTP 6-3-500.

6.1.2.2 Technical Inspection

Perform a technical inspection of the test item as described in the applicable sections of MTP 6-3-501.

6.1.2.3 Electrical Characteristics (where applicable)

Determine the electrical characteristics and the power requirements of the test item as described in the applicable sections of MTP 6-3-517.

6.2 TEST CONDUCT

NOTE: 1. Subtests shall be conducted concurrently with, or in conjunction with, other subtests, whenever applicable.
2. Unless appropriate data from the current Standard A manual FDC equipment is available, the current Standard A manual equipment shall be subject to the appropriate procedures of this MTP to be used for comparison with the test item results.

6.2.1 Operational Characteristics

NOTE: The procedures of paragraphs 6.2.1.1 through 6.2.1.3 shall be conducted under all conditions of weather prevailing during the test, simulating maneuver and combat conditions.

6.2.1.1 Emplacement, Preparation for Action and March Order

- a. Determine the time required to, difficulties encountered, and optimum crew size to emplace the test item, prepare it for action, and march order it as described in the applicable sections of MTP 6-3-505.
- b. Record the applicable data of MTP 6-3-505 and, when required for test items using electrical power, the following, as applicable:

- 1) Time required to:

- a) Warm up the test item, if applicable
- b) Perform all operational checks and adjustments

- 2) Difficulties encountered
- 3) Adjustments required

6.2.1.2 Operability

- a. Operate the test item to exercise technical fire control using typical sets of input data for a single battery.

- b. Record the times required for the following:

- 1) Preparation of firing charts and other manual equipment
- 2) Determining and recording replot data
- 3) Making polar plots
- 4) Applying registration corrections

- c. Observe and record all variations from standard manual fire direction procedures.

- d. Record the results of processed firing missions.

- e. Repeat steps a thru d with the following weapon configuration:

- 1) Two or more batteries
- 2) Two or more battalions
- 3) Mixed caliber weapons using a single firing chart

6.2.1.3 Accuracy

Evaluate the precision of components and the overall accuracy of the test item as follows:

6.2.1.3.1 Firing Chart - Perform the following:

- a. Measure the grid intervals on a random sample of firing chart to verify conformance to precision requirements of the appropriate research and development document.

- b. Measurements shall be made under each of the following conditions, if feasible:

- 1) Low humidity
- 2) High humidity

- 3) Precipitation
- 4) High temperature
- 5) Low temperature
- 6) Combinations of above, as feasible

NOTE: See paragraph 6.2.3.3 for "Effects of Weather" tests.

6.2.1.3.2 Graphical Equipment - Perform the following:

- a. Use the graphical components (range fans, protractors, wind cards, firing tables, site tables, etc.) to solve arithmetically proved problems and compare the test item component results with mathematical solutions.
- b. Record the input and output data of the graphical equipment and the arithmetic solutions.
- c. Measurements shall be made under the following conditions, if feasible:

- 1) Low humidity
- 2) High humidity
- 3) Precipitation
- 4) High temperature
- 5) Low temperature
- 6) Combinations of above, as feasible

d. Record the effects of environmental conditions on movable parts, scales, dials, etc.

6.2.1.3.3 System Accuracy - Perform the following:

- a. Process representative gunnery problems, that have been solved using a computerized system, through the test item for both observed and predicted firing missions.
- b. Manually insert the following inputs into the test item after receiving it over existing communication nets:

- 1) Weapon locations
 - a) Easting
 - b) Northing
 - c) Altitude
- 2) Target location (surveyed or estimated)
 - a) By coordinates and altitude
 - b) Estimated
 - (1) Coordinates
 - (2) Shift from known location
 - (3) Polar plot from known locations
- 3) Ballistic effects desired (shell, charge, fuze)

- 4) Meteorological data
- 5) Corrections to initial data
- 6) Other as required

c. Record the pertinent output data from the following test item output data:

- 1) Unit firing (battery, battalion, etc)
- 2) Shell
- 3) Charge
- 4) Fuze
- 5) Direction (Azimuth, deflection, or bearing)
- 6) Firing elevation
- 7) Site
- 8) Quadrant (sum of c.6 and c.7 above)
- 9) Changes to initial data, as required
- 10) Adjusted (Replot) data
- 11) Other, as required

d. Compare the results to computerized system or mathematically derived results or both.

6.2.2 Transportability Tests

6.2.2.1 Surface Transportability

a. Determine the surface transportability of the test item as described by the applicable sections of MTP 6-3-510.

NOTE: If no electrical equipment is involved the applicable transportation test of MTP 10-3-503 shall be used.

b. At the completion of the testing, subject the test item to a technical inspection as described by the applicable sections of MTP 6-3-501.

c. Verify the operability of the test item by subjecting it to the system accuracy test described in paragraph 6.2.1.3.3.

6.2.2.2 Air Transportability

NOTE: The conduct of air transportability testing shall be coordinated with the U. S. Army Airborne, Electronics and Special Warfare Board (USAAESWBD), if required.

6.2.2.2.1 Air Drop Capability - Perform the following:

a. Determine the suitability of the test item for air drop as prescribed by the applicable sections of MTP 7-3-512.

b. At the completion of testing, subject the test item to a technical inspection as described by the applicable sections of MTP 6-3-501.

c. Verify the operability of the test item by subjecting it to the system accuracy test described in paragraph 6.2.1.3.3.

6.2.2.2.2 Air Transportability (Internal) - Perform the following:

- a. Determine the suitability of the test item for internal (helicopter) air transport as described in the applicable sections of MTP 7-3-515.
- b. At the completion of testing, subject the test item to a technical inspection as described in the applicable sections of MTP 6-3-501.
- c. Verify the operability of the test item by subjecting it to the system accuracy test described in paragraph 6.2.1.3.3.

6.2.2.2.3 Air Transportability (External) - Perform the following:

- a. Determine the suitability of the test item for external air transport as described in the applicable sections of MTP 7-3-516.
- b. At the completion of testing, subject the test item to a technical inspection as described in the applicable sections of MTP 6-3-501.
- c. Verify the operability of the test item by subjecting it to the system accuracy test described in paragraph 6.2.1.3.3.

6.2.2.3 Man Transportability

Determine the suitability of the test item to be transported by an individual soldier, or soldiers, as follows:

- a. Transport the test item for a minimum of 500 meters, simulating combat conditions, using one man or the minimum number of men required.
- b. Record the following:
 - 1) Minimum number of men capable of transporting the test item
 - 2) Comments of transporting person(s) on ease of transport

6.2.3 Full Test Evaluations

Throughout the conduct of the service test, the following test item characteristics shall be determined and/or evaluated.

6.2.3.1 Durability

- a. Determine the durability and ruggedness of the test item as described by the applicable sections of MTP 6-3-506.

NOTE: The test item shall be transported over paved roads, unpaved roads, and cross-country terrain for a minimum of 300 miles, in all transportable configurations.

- b. Evaluate the ability of the test item transit case(s) to protect the test item from shock and vibration.

6.2.3.2 Maintainability and Reliability

NOTE: The overall evaluation of the maintainability and reliability of the test item shall be made according to the criteria of reference 4C.

- a. Complete the authorized maintenance tasks in accordance with the test item maintenance instructions and technical literature.
- b. Determine the maintainability of the test item as described by the applicable sections of MTP 6-3-524.
- c. Record the following, as applicable:
 - 1) Time and number of personnel required to perform scheduled and non-scheduled maintenance tasks on the test item.
 - 2) Frequency of repairs.
 - 3) Test item downtime (cumulative).
 - 4) Nomenclature of repair parts used.
 - 5) Maintenance responsibilities and capabilities at organizational, direct support and general support levels.
- d. Evaluate the adequacy of the test item maintenance package.
- e. Determine the test item reliability as described in the applicable section of MTP 6-3-524.

6.2.3.3 Effects of Weather

- a. Determine the effects of weather on the test item as described in the applicable sections of MTP 6-3-509.

NOTE: This subtest shall be run as an integral part of the accuracy subtest, since the significant effects of weather would effect component and subsequently system accuracy.

- b. Determine the adequacy of containers to protect the test item components from the effects of weather.

6.2.3.4 Human Factors

Evaluate the human factors engineering as described in the applicable sections of MTP 6-3-525 with emphasis on the following:

- a. Readability of scales
- b. Ease of applying correction data
- c. Fatigue inducing procedures

6.2.3.5 Safety

- a. Determine the test item safety hazards resulting from storage, transport, operation, and maintenance as described by the applicable sections of MTP 6-3-523.

- b. Prepare a safety confirmation in accordance with USATECOM Regulation 385-6.

6.3.2.6 Value Analysis

- a. Record observations concerning possible ways to eliminate unnecessary costs during the design, development and procurement of the test item without compromise to the following:

- 1) Quality of components
- 2) Overall accuracy
- 3) Maintainability and reliability

NOTE: Observations shall include, but shall not necessarily be limited to, non-essential or nice-to-have features, components or accessories.

b. Document findings if it is determined that the test item does not offer significant advantages or improvements over existing standard manual fire direction equipment.

6.2.4 Post-Test Inspection

Upon completion of testing the test item shall be subjected to a technical inspection as described by the applicable sections of MTP 6-3-501 and any deleterious effects on the test item due to the testing program shall be recorded.

6.3 TEST DATA

6.3.1 Preparation for Test

6.3.1.1 Personnel Training

a. Record the following for all military personnel:

- 1) Rank
- 2) MOS
- 3) Training in MOS, in months
- 4) Experience in MOS, in months

b. Record the adequacy of the training literature

6.3.1.2 Pre-Test Operations

6.3.1.2.1 Physical Characteristics -

Record data collected as described in the applicable sections of MTP 6-3-500.

6.3.1.2.2 Technical Inspection -

Record data collected as described in the applicable sections of MTP 6-3-501.

6.3.1.2.3 Electrical Characteristics (when applicable) -

Record data collected as described in the applicable sections of MTP 6-3-517.

6.3.2 Test Conduct

6.3.2.1 Operational Characteristics

a. Record the following during all operational characteristics tests:

- 1) Ambient temperature range in °F (e.g. from x° to y°).
- 2) Relative humidity, in percent.
- 3) Type of precipitation, if any.
- 4) Location of test item (field installation, FDC van, truck, tent, etc).

6.3.2.1.1 Emplacement, Preparation for Action and March Order -

Record data collected as described in the applicable sections of MTP 6-3-505 and the following for each operation under the various weather and conditions encountered:

a. Time required, in minutes, to:

- 1) Adequately warmup the test item, if applicable
- 2) Perform all operational checks and adjustments

- b. Difficulties encountered
- c. Adjustments required

6.3.2.1.2 Operability -

Record the following for each fire mission:

a. Mission type (single battery, two or more battalions, mixed caliber weapons, etc).

b. Time required to:

- 1) Prepare firing charts and other manual equipment
- 2) Determine and record replot data
- 3) Make polar plots
- 4) Apply registration corrections

c. Results of each firing mission.

d. Variations from standard manual fire direction procedures.

6.3.2.1.3 Accuracy -

a. Firing Chart:

Record the following for each measurement made:

- 1) Grid interval measured for each weather condition encountered
- 2) Effect of various weather conditions on grid interval accuracy

b. Graphical Equipment:

Record the following for each measurement made:

- 1) Input data
- 2) Output data for each weather condition encountered
- 3) Mathematical solution
- 4) Effect of moisture and extreme temperature on:
 - a) Moving parts
 - b) Scales
 - c) Indices
 - d) Dials

c. System:

- 1) Record the following for each mission:
 - a) Type of mission (predicted, observed)
 - b) Caliber of weapon used
 - c) Input data:
 - (1) Weapon location in easting, northing, altitude
 - (2) Target location (coordinates or coordinates and altitude)
 - (a) Method of determining (surveyed, estimate by plot, estimated by shift).
 - (3) Ballistic effects desired (shell, charge, fuze)
 - (4) Meteorological data, if applicable
 - (5) Corrections to initial data
 - d) Output data:
 - (1) Unit firing (battery, battalion, etc)
 - (2) Ammunition type
 - (3) Charge
 - (4) Fuze
 - (5) Firing direction (azimuth, deflection or bearing)
 - (6) Firing elevation in mils
 - (7) Site
 - (8) Quadrant (sum of 6 and 7)
 - (9) Corrections to estimated data
 - (10) Adjusted (replot) data
 - e) Computerized system output data
 - f) Mathematical solution data

6.3.2.2 Transportability Tests

6.3.2.2.1 Surface Transportability -

- a. Record data collected as described in the applicable sections of MTP 6-3-510 or MTP 10-3-503 as applicable.

b. Record technical inspection data, collected as described in the applicable sections of MTP 6-3-501.

c. Record data collected as described in paragraph 6.2.1.3.3.

6.3.2.2.2 Air Transportability -

a. Record data collected as described in the applicable sections of the following MTP's:

- 1) MTP 7-3-512 for air drop capability
- 2) MTP 7-3-515 for internal air transportability
- 3) MTP 7-3-516 for external air transportability

b. Record technical inspection data, collected as described in the applicable sections of MTP 6-3-501.

c. Record data collected as described in paragraph 6.2.1.3.3.

6.3.2.2.3 Man Transportability -

Record the following:

- a. Minimum number of men capable of transporting the test item
- b. Comments of person(s) transporting test item

6.3.2.3 Full-Test Evaluations

6.3.2.3.1 Durability -

Record the following:

- a. Data as collected under the applicable sections of MTP 6-3-506.
- b. Ability of the test item transit case(s) to protect it from shock and vibration.

6.3.2.3.2 Maintainability and Reliability -

Record the following:

- a. Data as collected under the applicable sections of MTP 6-3-524.
- b. Type of maintenance performed (scheduled, non-scheduled).
- c. Time required to perform each maintenance task, in hours and minutes.
- d. Number of personnel required to perform each maintenance task.
- e. Frequency of repairs over the period of testing (record dates).
- f. Test item downtime (cumulative), in hours and minutes.
- g. Nomenclature of repair parts used.
- h. Maintenance responsibilities and capabilities at organizational, direct support and general support levels.

6.3.2.3.3 Effects of Weather -

Record the following:

- a. Data as collected under the applicable sections of MTP 6-3-509.
- b. Adequacy of containers to protect the test item components from the effects of weather.

6.3.2.3.4 Human Factors -

Record the following:

Record data as collected under the applicable sections of MTP 6-3-525 including:

- a. Readability of scales
- b. Ease of applying correction data
- c. Fatigue inducing procedures

6.3.2.3.5 Safety -

Record data as collected under the applicable sections of MTP 6-3-523.

6.3.2.7.6 Value Analysis -

Record observations concerning possible ways to eliminate unnecessary costs during the design, development and procurement of the test item without compromise to the following:

- a. Quality of components
- b. Overall accuracy
- c. Maintainability and reliability

6.3.2.8 Post-Test Inspection

- a. Record data as collected under the applicable sections of MTP 6-3-501.
- b. Record any deleterious effects of the test program on the test item.

6.4 DATA REDUCTION AND PRESENTATION

Data obtained from all subtests covered by applicable MTP's shall be summarized and evaluated according to procedures described in those applicable MTP's. Appropriate charts, graphs, and tabulated summaries shall be used to present the data in a clear manner. Special consideration shall be given to any condition or circumstance contributing to any test result.

Calculations shall be performed as specified by the individual MTP's and references, wherever applicable, and all photographs, motion pictures and illustrative material shall be suitably identified.

The qualitative and quantitative data collected shall be evaluated in terms of the requirements specified in the QMR's and TC's, which are applicable, to determine the degree of fulfillment of the test item performance specifications, and comparisons shall be made with results attainable with current Standard A equipment that the test item was designed to replace to determine if there are potentially significant improvements or advantages through acceptance of the test item.

A safety confirmation based on the data of paragraph 6.3.2.7.6 shall be presented in accordance with USATECOM Regulation 385-6.